

the finest Injection; opening the Stomach and Intestines they contained a mucous Matter, the greatest Part of which was Blood, and the fine *villous* Coat which is so visible in these Animals was entirely destroyed. About an Hour before he was bit he had a plentiful Meal of coarse Beef, of which there was not the least Appearance. Opening the *Thorax*, the *Pleura* and other Membranes looked as if injected; the Heart was turgid with Blood, as were also its Vessels. The Vessels of the Membranes of the Brain made a most beautiful Figure from the Quantity of Blood contained in them, as did likewise the Blood-Vessels of the Nerves; there was a small Quantity of Water between the two Hemispheres. The Blood contained in the Heart and its Vessels was an even Mass about the Consistence of Cream. The Cat had upon opening nearly the same Appearances, and lived about five Hours.

II. *A Letter from the Rev. Dr. Samuel Clarke to Mr. Benjamin Hoadly, F. R. S. occasion'd by the present Controversy among Mathematicians, concerning the Proportion of Velocity and Force in Bodies in Motion.*

S I R,

IT has often been observed *in general*, that *Learning* does not give Men *Understanding*; and that the absurdest Things in the World have been asserted and maintained, by Persons whose Education and Studies

dies should seem to have furnish'd them with the greatest Extent of Science.

That Knowledge in many *Languages* and *Terms* of *Art*, and in the History of *Opinions* and *Romantick Hypotheses* of Philosophers, should sometimes be of no Effect in correcting Mens *Judgment*, is not so much to be wonder'd at. But that in *Mathematicks* themselves, which are a *real Science*, and founded in the *necessary Nature of Things*; men of very great Abilities in *abstract* Computations, when they come to *apply* those Computations to the *Nature of Things*, should persist in maintaining the most *palpable Absurdities*, and in refusing to see some of the most *evident and obvious Truths*; is very strange.

An extraordinary Instance of this, we have had of late Years in very eminent Mathematicians, Mr. *Leibnitz*, Mr. *Herman*, Mr. *'sGravesande*, and Mr. *Bernoulli*; who (in order to raise a *Dust* of Opposition against Sir *Isaac Newton's* Philosophy, the Glory of which is the *Application* of *abstract Mathematicks* to the *real Phænomena of Nature*;) have for some Years insisted with great Eagerness, upon a Principle which subverts all Science, and which may easily be made appear (even to an ordinary Capacity) to be contrary to the *necessary and essential Nature of Things*.

What they contend for, is, That the *Force* of any *Body in Motion*, is proportional, not to its *Velocity*, but to the *Square of its Velocity*.

The *Absurdity* of which Notion, I shall first make appear, and then shew *what* it is that has led these Gentlemen into Errour.

In the Nature of Things, 'tis evident, every *Effect* must necessarily be *proportionate* to the Cause of that Effect;

Effect ; that is, to the *Action* of the Cause, or the *Power exerted* at the *Time* when the Effect is produced. To suppose any *Effect* proportional to the *Square* or *Cube* of its Cause, is to suppose that an *Effect* arises *partly* from its Cause, and partly from * *Nothing*.

In a *Body in Motion*, there may be considered distinctly, the *Quantity of the Matter*, and the *Velocity of the Motion*. The *Force* arising from the *Quantity of the Matter* as its Cause, must necessarily be *proportional* to the *Quantity of the Matter* : And the *Force* arising from the *Velocity of the Motion* as its Cause, must necessarily be *proportional* to the *Velocity of the Motion*. The *whole Force* therefore arising from these *two Causes*, must necessarily be *proportional* to these *two Causes taken together*. And therefore in Bodies of *equal Bigness and Density*, or in *one and the same Body*, the *Quantity of Matter* continuing always the *same*, the *Force* must necessarily be always *proportional* to the *Velocity of the Motion*. If the *Force* were as the *Square* of the *Velocity*, all that *Part* of the *Force*, which was *above* the *Proportion* of the *Velocity*, would arise either out of *Nothing*, or (according to Mr. *Leibnitz's* Philosophy) out of some

* Which is just like the *Supposition* made by those Mathematicians, who have taken it for granted, that $\frac{\infty}{\infty}$ is equal to *Infinite* ; that is, that as 0 to 1, so 1 is to *Infinite* ; that is, that *Infinite* multiplied by 0, is equal to 1, or an infinite Number of *Nothings* equal to *Something* ; which is palpably false. The true *Proportion* is, not as 0 to 1, so 1 to *Infinite* ; but as an *Infinite* is to 1, so is 1 to *Infinite*. And as the *Infinite* of an *Infinite* (that is, a second Fluxion, or the second Power of *Infinite*) is to 1, so is 1 to *Infinite*, or the second Power of *Infinite* ; that is, (for Instance) 'tis as a finite [physical] Line to an *Infinite* Surface, or as a finite [physical] Surface to an *infinite* Solid. And as 0 (which is beyond all *Proportion* lower than the *Infinite* Power of an *Infinite*) is to 1, so is 1 to that which is beyond all *Proportion* higher than the *Infinite* Power of *Infinite*. Which clearly removes the Foundation of all the ridiculous Consequences, which have been drawn from the *Supposition* of the fore-mention'd false *Proportion*.

living

living Soul essentially belonging to *every Particle of Matter*.

Whenever *any Effect* whatsoever, is in a *duplicate Proportion*, or as the *Square* of any *Cause*; 'tis always either because there are *two Causes* acting at the *same Time*, or that *one and the same Cause* continues to act for a *double Quantity of Time*.

The *Resistance* made to a *Body* moving in any *fluid Medium*, is in a *duplicate Proportion* to the *Velocity* of its *Motion*; because, in *Proportion* to its *Velocity*, it is resisted by a *greater Number of Particles* in the *same Time*; and again, in *Proportion* to its *Velocity*, 'tis resisted by the *same Particles singly* with a *greater Force*, as being to be moved out of their *Places* with *greater Velocity*.

Light decreases in a *duplicate Proportion* of its *Distance* from the *Sun*; because the *Rays* *divaricate* according to *two Dimensions*; according to the *Dimension upwards* or *downwards*, and according to the *Dimension side-ways*. But according to the *third Dimension forwards* from the *Sun*, a *Ray of Light* undergoes no *Alteration*; because the *Particles*, of which it consists, being emitted all of them with an equal *Velocity*, continue every where at an equal *Distance* from each other.

One and the *same Cause*, acting in a *double Quantity of Time*, produces the *same Effect*, as *two equal Causes* acting in a *single Quantity of Time*. *One* and the *same Force*, in *two Parts of Time*, will cause a *Body in Motion* to describe the *same Space*, as *double the Force* would do in *one Part of Time*. The *Space described* therefore by a *Body in Motion*, is not as the *Force*; but as the *Force* and the *Time* taken together.

A Body, with any the *least assignable Force*, will move through *infinite Space*, if it meets with *no* Resistance, in an *infinite Time*. And in Spaces where there is an *uniform* Resistance to Motion, the *Space described* before the Motion ceases, must needs be as the *Force* and as the *Time* together: Because a *double Force* will carry a Body *twice as far* in the *same Time*, and will also cause the Motion to be *twice as long Time* in *destroying* by an uniform Resistance. The *Space described* therefore before the Motion ceases, is in this Case demonstrably as the *Square of the Force*. A Body *thrown upwards* with *double Force*, will be carried *four Times* as high, before its Motion be stopp'd by the uniform Resistance of Gravity; because the *double Force* will carry it *twice as high* in the *same Time*, and moreover require *twice the Time* for the uniform Resistance to destroy the Motion. The Case is the same in *accelerated Motion*; in Bodies *accelerated* by a Succession of elastick Impressions, or *falling* with a Motion accelerated by the uniform Power of Gravity, or by any other uniform Power whatsoever. The *Space described* must needs be as the *Force*, and as the *Time wherein* the Force operates.

What I have thus demonstrated concerning *any Force*, considered as the *Cause* producing an Effect; and concerning the *Time*, during which the Force operates; is on all Hands acknowledged to be true concerning *Velocity*. And therefore *Velocity* and *Force*, in this Case, are one and the same Thing. So that to affirm *Force* to be as the *Square of the Velocity*, is to affirm that the Force is *equal* to the *Square of it self*.

Now from hence appears very clearly the *Ground* of the *Errour* these Gentlemen have fallen into, and

of their *Misapplication* of the Experiments they build upon.

The *Effect* of a *Force* impress'd on a moveable Body, is the *Motion* of that Body from one Place to another. Now forasmuch as the *Effect* cannot but be proportional to its *Cause*, hence Mr. *Leibnitz* (whom the other Gentlemen have follow'd) contends that the *Space describ'd* by a Body in falling, is proportional to the *Force* by which it is impell'd during its Fall; and that the *Force* acquir'd by a Body in falling, is proportional to the *Space it has described* in its Fall. Which *Space* being agreed to be as the *Square of the Velocity* (as being proportional to the *Velocity* and to the *Time taken together*) hence they infer that the *Force* likewise is as the *Square of the Velocity*.

But from what has been said, 'tis plain, that the *Space described* in these and all other the like Cases, is not as the *Force* only, but as the *Force* and as the *Time wherein* the *Force* acts; that is to say, as the *Square of the Force*. For the *Cause* of the *Quantity of the Space described*, is not barely the *Quantity of the Force*, but also the *Continuance of the Time* wherein the *Force* acts. The *Force* therefore and the *Time taken together*, being necessarily as the *Space described*; as the *Velocity* and the *Time taken together*, are on all Hands acknowledg'd to be; it follows that the *Velocity* and the *Force* are equal, and not the *Force* as the *Square of the Velocity*.

When two *unequal* Bodies fastened at the Ends of the *Arms* of a Balance of *unequal Length*, counterpoise each other, and vibrate in *equal Times*; as they must necessarily do, being *fastened* to the *Arms* of the *same* Balance: which is an Observation Mr. *Leibnitz* lays great Stress upon: In *That* Case indeed the *Forces* will

will be as the *Spaces described*. But not therefore as the *Squares of the Velocities*. For in *That Case*, the *Velocities themselves* are as the *Spaces described*, because the *Times* are equal.

When a Body projected with a *double Velocity*, enters *deeper* into *Snow* or *soft Clay*, or into a Heap of *springy* or *elastick* Parts, than in Proportion to its *Velocity*; 'tis not because the *Force* is more than proportional to the *Velocity*; but because the *Depth* it penetrates into a soft Medium, arises partly from the *Degree* of the Force or Velocity, and partly from the *Time wherein* the Force operates before it be spent.

In the Collision of *hard* Bodies, 'tis (I think) agreed on all Hands, that 'tis *demonstrated* by *Reason*, and confirmed by *Experience*; that when a perfectly hard Ball, moved with *whatever* Degree of *Velocity*, strikes full upon another hard Ball, equal in Bigness and Weight, and without any Motion in it; if the Balls be *unelastick*, they will both go on together the same Way, dividing the Motion equally between them, with *half the Velocity* the first Ball had originally: But if they be perfectly *elastick*, the moving Ball will communicate its whole *Motion and Velocity* to the quiescent Ball, and it self *lie still* in the others Place. Were it true now, that the *Force* of the *moving Ball* was as the *Square of its Velocity*; these Experiments would then shew (which is infinitely absurd) that the *Force* or *vis inertiae* in the *quiescent* Ball, the *dead* Force, was always proportional to the *Square of the Velocity* (which these Gentlemen affect fantastically to call the *living* Force) of the *moving* Ball, whatever its Velocity were. Or the *Force* in *Both* might just as reasonably be supposed to be as the *Cube*, or the *quadrato-quadrato*, or any *other Power* of the Velocity of the *moving* Ball. Which is turning the *Nature*

of *Things* into Ridicule. Mr. *Leibnitz*, in some Letters which he wrote into *England*, intimated that he had a Prospect of a *perpetual Motion*, founded on the Notion of a *Vital Principle*, or *active Power* in *Matter*. But from the Experiments now mentioned, 'tis evident that if the *Force* of Bodies in Motion could be exalted even to the *infinitth Power* of their *Velocity*; yet since, to answer the Phenomena of Nature with Regard to *Action* and *Re-action*, the same *Force* must necessarily be allowed to all *quiescent* Bodies likewise; it could be of *No Effect*.

III. *Astronomical Observations made at Vera Cruz, by Mr. Joseph Harris. Revised and communicated by Edm. Halley, L.L.D. Astron. Reg. & R. S. S.*

THE Latitude of this Place I found (by several distant Observations made by a Quadrant of four Feet Radius) to be $19^{\circ} 12' N$.

On *March 11, 1727. O. S.* there happen'd here a considerable Eclipse of the Sun, the greatest Obscuration being about $10\frac{1}{2}$ Digits; and having that Morning carefully adjusted the Pendulum Clock, and fixed a Telescope to the Index of the foresaid Quadrant, I observed it to begin in or about the *S. E.* by *S.* Part of the Sun's Disk at $49\frac{1}{2}$ Minutes after Noon apparent Time; the Altitude of the Sun's Center then was $67^{\circ} 53'$.

We could not determine exactly the Middle of this Eclipse, but as near as we could judge, it happen'd about $2^h 30^m$ P. M.